

AMATEUR SATELLITE REPORT

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Editor: Vern Riportella, WA2LQQ

Contr. Editors:

Eric Rosenberg, WA6YBT

Pete Killingsworth, KD7WZ

Paul Roemer, KG6LC

Managing Editor: Bob Myers, W1XT

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Short Bursts

- The Radio Society of Great Britain has helped the University of Surrey to obtain a special events call sign, GB2UP, for special third party traffic operation of its Digital Communications Experiment (DCE) on UO-11. One result is that packet radio stations in many nations, (including the USA) will soon be able to send packets to Europe and elsewhere using the DCE on UO-11 using the intermediary of authorized DCE gateways. The details are yet to be worked out but several authorized DCE stations exist (NK6K, N5BRG and WA9FMQ) in the USA to forward traffic. More on this development as details become available.
- The WØRPK-AMSAT Bulletin Board System is now running on a dedicated personal computer and telephone line. The telephone number remains 515-961-3325. Pre-registration is no longer required for access to AMSAT News Service bulletins, the latest orbital elements and UoSAT News. The system is continuously available to those interested in OSCAR-related activities 24-hours per day, seven days per week. The system is now equipped with a 300-1200-2400bps modem. Additional system enhancements are being planned according to Sysop Ralph Wallio, WØRPK.
- ROAR is the Rotarians Of Amateur Radio, a group of 850 across the globe. ROAR recently donated \$2000 to AMSAT. In a letter to AMSAT Vice President Ralph Wallio, WØRPK, ROAR Secretary Robert L. Butler, WB7RQG, explained: "Our purpose is to spread fellowship and better understanding around the world through Amateur Radio. We feel that the satellite concept is a great tool to be used for that purpose." AMSAT definitely concurs and deeply appreciates ROAR's clear insight to our motivations. Thanks!
- The launch of RS-9 and RS-10 is still on hold. The candidate launch windows now seem to be converging on late March or early April. Launch aboard the SL-13 or the new SL-16 medium launch vehicle is possible according to usually reliable sources. PAØDLO has now revised his earlier report on the nature of RS-10's Robot. Nico now reports it is a Mode K robot (15 meters up, 10 meters down) rather than the previously reported Mode T robot (15 meters up, 2 meters down).

Phase Four Initial Design Proceeding Very Well

According to Jan King, W3GEY, efforts are now accelerating in firming definitions and specifications for AMSAT's first geosynchronous satellite program, Phase 4. Jan is AMSAT's Engineering Vice President and oversees the Phase 4 design effort. He envisions a 1991 initial operational capability for the first Phase 4 bird.

A team of more than 20 professional engineers and scientists within AMSAT are now engaged in intense system and architectural studies which will lead to a Phase 4 design concept by year's end. Dick Jansson, WD4FAB, Phase 4 Engineering Administrator, reports important breakthroughs in 5 key areas insure Phase 4 will not only be the most advanced and capable OSCAR to date, but that it will actually advance the state-of-the-art in several key technologies. Many of the innovations

now envisioned by AMSAT engineers have never been employed before in any spacecraft.

Among these innovative technologies are Fluid Momentum Control (FMC), a unique momentum control concept pioneered by Lou McFadin, W5DID of Houston, an engineer with NASA at the Johnson Space Center. Bob McGwier, N4HY, of Princeton, N.J. is working on the system with Lou. The system envisioned would eliminate the momentum wheel required by three-axis stabilized spacecraft such as Phase 4. The momentum wheel is very expensive and since it has moving parts, it represents potential failure node. The FMC concept will pump a ferro-magnetic fluid around the spacecraft for momentum transfer and control. The pumping would be done magnetically to eliminate a motor driven pump.

Bob McGwier is also teamed with Phil Karn, KA9Q, on a unique spread spectrum ranging technique. It is envisioned as allowing ultra-precise location of Phase 4 in orbit by using an entire transponder passband spectrum while not interfering with on-going communications on the transponder.

Dick Jansson, WD4FAB, has completed the initial cut on the spacecraft's thermal design. Dick says that the use of a heat pipe design on the spacecraft will allow precise temperature control across its entire surface.

In the area of transponder electronics, Karl Meinzer, DJ4ZC of AMSAT DL, has provided a continuous stream of improvements in the HELAPS technology which will allow for its use at higher frequencies than ever before including, perhaps, even at S-Band, 2.4 GHz. HELAPS stands for High Efficiency Linear Amplification by Parametric Synthesis. In general, it is a means of improving the efficiency of linear amplifiers such as used in OSCAR transponders to unprecedented levels. This technology is patented and highly coveted for its efficiency. Added to this is the remarkable technique for digital communication called RSM (Rectangular Spectrum Modulation) also pioneered by Dr. Meinzer. Both HELAPS and RSM will likely be used on Phase 4 and, if AMSAT DL decides to push forward with Phase 3D, as now seems likely, these state-of-the-art technologies will certainly be employed there as well.

James Miller, G3RUH, is investigating the use of digital signal processing techniques on Phase 4. These would automatically null selected uplink passband frequencies when an uplink signal appearing there exceeded a certain threshold. This technique, if employed in Phase 4, could provide the long-sought relief from alligator abuse, a lingering concern with linear transponders. The technology may be especially relevant where a hemispheric satellite footprint opens new risk areas of both inadvertent and malicious interference to transponder communication activities routine and otherwise.

In the area of propulsion, Rick Fleeter, WA8VGK, has developed an innovative concept for attitude control jets. These will insure Phase 4 points in the right direction, right at the earth. Unlike any other prior OSCAR, Phase 4 will not spin or tumble but be stable in three axes. To maintain that stability, occasional "nudges" need to be applied to the spacecraft. Those "nudges" come from small jets on board. Rick's innovation is in the type of fluid used for the jets and their efficiency. Since the fluid is expendable, the overall lifetime of the spacecraft is limited by the quantity of consumables carried aboard. Thus the efficiency of the propellant is paramount. Fleeter's concept apparently is one of the most advanced ever conceived.

The Phase 4 design effort is off and running with a remarkable degree of enthusiasm and innovation evident throughout the design team. More talent is being brought on-board every day. Recently Mike Staal, K6MYC, joined the team. Mike's specialty is antenna design. One of the founders of KLM, he designed many of their space communication antennas including all the current crossed yagis such as the 18C, 22C and 40CX beams. Mike will tackle Phase 4 VHF and UHF antenna design. Also recently joining the design team is Gordon Woodcock, President of the L-5 Society. Gordon is a hardware systems engineer at the NASA Marshall Space Flight Center.

The current Phase 4 design effort has the immediate objective of developing a concept and initial design to present to the Board of Directors for possible full scale development funding by the close of 1987. A concept review meeting, the first in a series of Phase 4 review meetings, was being planned for the weekend of April 3, 4 and 5 in Boulder, Colorado.

Digital Signal Processing in Amateur Radio

Tom Clark, W3IWI and Bob McGwier, N4HY

We have begun experimentation with digital signal processing (DSP) techniques which we feel may revolutionize certain aspects of Amateur Radio. We each have a Texas Instrument TMS32010 co-processor board running in our PC-clones. The 320's on-board RAM is dual-ported to the PC and is used to communicate between the two CPUs. The 320 board also has attached to it high-speed (40 kHz) A/D & D/A converters plus a programmable timer driving the A/D's sample & hold circuit.

The PC serves both as a display device and does high-level data processing. Code we are running is written in TMS320 assembler (on the 320 side) and Microsoft "C" (for the PC side). Rudimentary software doing FFT spectral analysis was demonstrated at the November AMSAT meeting in Dallas and at the February TAPR meeting in Tucson where it was used to show the modulation spectrum of the PSK modems.

We see many possible applications for DSP techniques. A few include:

- Optimized modems for HF, PSK and satellite telemetry use. When you need a different modem, you plug in new software instead of building new hardware.
- Weak-signal signal-enhancement. Preliminary indications are that between 10 & 20 dB of s/n improvement can be realized. Silicon in your computer can replace aluminum in antennas! More on this application in a minute.
- Digital video processing so that pictures can be crammed onto a low-speed packet channel. It even looks like a WEFAX weather satellite signal display could be done all in software using your PC's display for the pictures.
- ACSSB signal processing is a natural. DSP techniques also lend themselves to processing digital voice for transmission over packet channels.
- etc. The list could go on all day.

The first code we have worked on is a real-time FFT (Fast Fourier Transform) spectrum analyzer adapted to communications applications. The test software we have been using makes 256 channels with an arbitrary bandwidth (up to 10-20 kHz). Where a conventional spectrum analyzer takes a single filter and sweeps it across the band, our FFT is the equivalent of 256 filters which leads to much higher sensitivity. We have included the ability to "stack" multiple spectra on top of each other for still higher sensitivity and to read out the frequency of the biggest peak.

This software has already been used as a measurement tool for 3 projects: at W3IWI it has been used as a piece of test equipment for testing the radio/PSK modem interface. W3IWI has also used it to study fading and QRM problems experienced by the 14.109 BBS interconnect network.

But the application we are most excited about involves the weak-signal world. At about 03:00 UTC on February 28, W3IWI and N4HY used the DSP FFT software on a real 432 MHz weak signal path (about 100 miles long) with EXCELLENT success. In this first DSP QSO we were able to attenuate the signals well below the threshold of audibility and still detect them reliably. N4HY has used his AO-10 satellite station (100 watts with a single yagi) and has been able to get echoes off the moon detectable with DSP. We are now working to define a communications protocol so that we will be able to use these techniques to exchange information.

The purpose of this preliminary report is to see if any other folks are interested in similar pursuits. We are considering proposing a joint AM-

SAT/TAPR project to coordinate the development of DSP hardware and software for a number of Amateur applications. We would like to hear from you as to whether you think DSP has a future in Amateur Radio and your ideas on how such a project should be organized.

Finally, you should note the TMS32010 boards we are using are commercially available at a cost of about \$800. If, however, there were to be a substantial interest evident in terms of units sold, it is reasonable to expect that initial price to be reduced by 2-3 dB\$.

FO-12 JD Testing Continues

Extensive testing of the FO-12 Mode JD digipeater function took place throughout March. During March the experimental FO-12 operating schedule had "On" days of Tuesday, Thursday and Saturday with "Off" days of Monday, Wednesday, Friday and Sunday. At press time JAMSAT liaison Tak Okimoto, JA2PKI, said the same general schedule may be used in the near future. Mode JD was to be activated every other 5 minutes of every other 2 hour period during the "On" days. This may change so be sure to check the AMSAT nets for latest schedules.

Testing of Mode JD may be interrupted at any time for testing of the new "Mailbox" software which is expected to commence soon. Other tests planned are designed to assess the relative power consumption of both Modes JA and JD in order to determine an operating schedule commensurate with available power resources.

FO-12 was launched last August 12 and employs two transponders. Using the Mode J framework, 2 meters up and 70 cm down, Mode JA is a linear transponder for analog modes. Mode JD is a digital mode for packet radio communication. Mode JD uplinks are FSK. The downlink is PSK. Several specially designed modems are now available to interface packet radio TNCs to the satellite. These have been detailed in the ASR and QEX publications of AMSAT and ARRL. G3RUH details how to interface his new FO-12 modem to various packet radio TNCs, aside from the TAPR TNC-1 or 2 elsewhere in this issue.

Observation of the FO-12 beacon is a reliable indicator of the mode then in use. The Mode JA beacon is at 435.795 MHz. The Mode JD downlink and beacon is at 435.910. Doppler shift of the beacon can approach ± 10 kHz. JA passband and JD channel details appeared in ASR #119 and 130.

UoSAT OSCAR 11 Begins Fourth Year Of Operations

UoSAT OSCAR 11, also known as UoSAT-2, was three years old on March 1st. Launched at 17:59 UTC, March 1, 1984 aboard a NASA Delta rocket, UO-11 was a "Hurry-Up" project that responded very quickly to an unanticipated launch opportunity identified by NASA. The spacecraft was completed in only six months demonstrating one of the field's most remarkable reaction times!

Following the complete resolution of some early "teething" troubles, UO-11 has provided excellent operational service supporting a wide range of experiments. Notable among these are: Digital Communications Experiment, Particle Wave Experiment, CCD Imaging Experiment, Gravity Gradient Stabilization Experiment, DIGITALKER Experiment and the DIARY system.

Coordinating the operation of these experiments and maintaining the correct status of the spacecraft has been left to the spacecraft on-board computer (OBC) running an operating system called "DIARY". DIARY has allowed far greater flexibility and variety in spacecraft operations than could be effected by ground command alone. DIARY has played an essential role in the successful gravity gradient stabilization experiments.

The success of each of these experiments and activities must continuously be measured against the background of how quickly the entire package was pulled together. The objectives of high reliability and responsiveness to an impending launch opportunity are usually mutually exclusive. Surrey's simultaneous achievement of both key objectives further distinguishes the program, its managers and engineers.

Additionally, the overhaul of the University of Surrey Control Center during 1986 has resulted in significant improvement in the efficiency of spacecraft operations.

In related news, the first edition of the UoSAT Data Booklet is now out of print. A second, revised edition is being prepared. Those who have

recently requested copies of the Booklet may anticipate a minor delay pending completion of printing the new second edition.

For several months Wednesday has been UO-11 Educational Operations Day with the DIGITALKER in use and minimum interruption of the 2-meter downlink. Discussions with educators using UoSAT have led to some significant modifications to Wednesday operations. Very often, UoSAT groundstations in schools have only a single microcomputer for data capture and display. The usual rapid switching of downlink data by the DIARY means that users have to frequently switch data display programs thus losing much data in the process. To reduce this problem, the DIARY will now send a much simplified data rotation on Wednesdays: 0000-1200 UTC DIGITALKER (15 sec.) Telemetry (4 min.) 1200-2359 UTC Constant Whole Orbit Data (WOD) dumps

The morning's telemetry dumps should allow easier data capture for live demonstrations and also provide interesting data for analysis of medium-term trends in all UO-11 telemetry channels. The continuous WOD dump in the evening will mean that much more WOD can be captured, including the seldom seen final interleaves of the data.

On Wednesday, the UoSAT groundstation will suspend all but emergency operations. Thus, UK school stations will get uninterrupted 2-meter data. DCE groundstations will suspend operations on this day also to provide the rest of the world with reliable space education-related access to the downlink.

UO-11 attitude maneuvers, under the control of the OBC, have proceeded very well resulting in good gravity-gradient lock with the CCD camera Earth pointing once again. The OBC algorithms will continue to run while Surrey evaluates the precision with which they may maintain UO-11 nadir pointing. Most UO-11 WOD surveys will be devoted to the magnetometer channels and status channel 61. Successful completion of this first phase of maneuvers means that a number of other spacecraft experiments (such as Particle wave, CCD and 2.4 GHz transmissions) may now continue.

TAPR's PSK Modem Project

Tom Clark, W3IWI

At the Tucson Area Packet Radio (TAPR) meeting February 21, we showed the "Alpha" prototype of the TAPR PSK modem. The project is now nearly ready for public announcement. As is often said about such activities "REAL SOON NOW" — but this time we mean it! I would guess that we will be able to announce the PSK modem being available during March. This note is intended as a status update on the project.

The circuit boards have been CAD'd by Erik Gustavson, N7CL. We ran off an initial "Alpha" batch of 5 boards. Not surprisingly, a few minor "gotchas" were found, all of which were minor. These were quickly corrected. The last chore remaining is to convert W3IWI's notes into a set of usable documentation.

The final parts list is being negotiated. Right now the only outstanding issues are whether the kit will include the recommended set of switches or whether the user will be told to get them at Radio Shack. We have decided that it is best for the user to get the cabinet at Radio Shack. The other final issue to be settled is the quantity of stuff to be ordered for the first batch; this is coupled to a request from JAMSAT to offer the TAPR implementation to their members [interesting aside — the basic design as published in August '86 QEX came from Japan! — sometimes things go full circle]. If any other groups want in on the first batch, let us know right away.

The modem works quite well. The final proof came recently when I fired it up on the air to work FO-12. I was able to achieve 99% copy on the satellite with no problems apparent. The first time I sent a packet to FO-12 it came right back at me. Eye-patterns on the satellite were exceptional.

A few sidenotes may provoke some thoughts. Although the 10 meter band is dead now, it will come back to life soon. Since 10 meters has been opened to full use by Novice and Technician class Amateurs and since 10 m is the lowest band on which we in the U.S. can run 1200 baud, the TAPR modem kit could be a natural for this as-yet-undeveloped HF packet band. Should we push PSK as THE 10 m standard? Several years ago ZL1AOX and I ran a lot of 400 baud (AO-10 format) packets on 10 m and the performance was superb. The PLL tracking loop performance on the PSK modem, coupled with the digital AFC designed for satellite use, should make tuning pretty easy. Coherent PSK should be several dB better than conventional incoherent FSK. Comments are solicited.

Progress On the G3RUH

PSK FO-12 Modem

by James Miller G3RUH

(Using it with the PK-64, PK-232 and TNC-220 TNCs)

As spelled out in my February 1987 *Ham Radio* article and in the PCB instructions, the modem is NOT confined for use solely with a TNC-1 or TNC-2. Specifically I have had many enquiries about how to use the G3RUH FO-12 modem with the AEA PK-64, AEA PK232 and Pac-Comm TNC220 because: PK-64 has no proper facilities for connecting an external modem; the PK232 has no TXclock output at its connector 5 pin connector and the TNC-220 has a 20 pin IDC connector with a non-standard pinout, and no TXclock. However all 3 TNCs can be used. Here's what to do.

GENERAL

There really is no mystery about the interconnections between TNC and modem. Not surprisingly, the required signals are Received Data, Transmitted Data, a Transmitter clock and common Ground. These signals are abbreviated to RXdata, TXdata, TXclock and GND. In addition, if you want to restore normal receive operations with a switch on the modem, the TNC's own Rxdata needs to be brought out as well (RXdataout) so it can be routed back in again.

I think these signals' functions are self explanatory but there still seems to be confusion about TXclock. The modem has to exclusive-or (EXOR) the 1200 bit/sec transmitted data with a synchronized 1200 Hz clock to create the (Manchester coded) transmitted audio.

This 1200 Hz clock is nominally derived in the modem by dividing the TNC-2's 19.2 kHz signal TXclock by 16 in modem 4040 chip U6. Now a 4040 is a 14 stage divider, so if 19200 Hz isn't available to drive it, then some other frequency will do. Nearly all TNCs have a 2.4576 MHz crystal oscillator and the 4040 can be wired to divide this down to 1200 Hz quite happily! However, most have 19.2 kHz somewhere inside them.

So, here are specific notes about the 3 TNCs.

AEA PK-64 and G3RUH FO-12 MODEM

AEA has provided no easy access (such as a "modem-disconnect jack") to the required 3 signals and GND. Thus, you will have to "winkle out" TXdata, RXdata and TXclock with flying leads, etc. The following notes are my reading of the circuit diagram, AEA's drawing 012-049.

TXDATA: This is available the 8530 serial I/O chip U3 pin 25, and should be connected to modem J2-19.

RXDATA: At present this enters U3 at 13/18, having come from driver transistor Q8 and pull-up R61. I would suggest breaking this at Q8 by simply lifting its collector lead. Take the 8530 side of the track (i.e. the pad) to the common of a SPDT switch, with one pole going back to Q8's collector lead, and the other to the FO-12 modem signal RXdata on J2-17. (The switch allows restoration to Normal operation).

TXCLOCK: The ultimate requirement is a 1200 Hz clock at the modem's TP4, synchronous with the data. The only PK-64 clock I can spot is the crystal oscillator which provides 2.4576 MHz to U3 pin 20. Connect this signal in a screened cable to modem J2-12. Wire the modem's 4040 divider signal U6 pin 15 to TP4, and OMIT LKC.

GND: A common connection is needed to the modem. Connect the 2.4576 MHz cable screen to U3 pin 31, and the other end to modem J2-15.

AEA PK-232 and G3RUH FO-12 MODEM

(Based on AEA circuit diagram 012-052). This TNC provides some of the signals at the five pins of J8, which should be connected thus:

Signal	PK232 J8	G3RUH MODEM J2
RXdata	1	17 see below
TXdata	2	19
Gnd	4	15
Txclock	see below	12

RXDATA: Cut the jumper link at JP4 and re-bridge center to the other side. Alternatively, if you want to be able to restore normal receive operation easily, cut the link and connect the common of an SPDT switch to the center pin of JP4 and the poles to the outer pins of JP4.

TXCLOCK: Obtain 19.2 kHz from the TNC's 74LS393 divider chip U8 pin 11 and connect to the modem at J2-12, modem link LKC to "TNC-2".

Pac-Comm TNC-220 and G3RUH FO-12 MODEM

(Based on Pac-Comm circuit diagram rev 1.2) This TNC provides some of the signals at 20 pin IDC facility J5. The pinout is NOT the same as in a TNC-1 or TNC-2 (such as their own TNC-200), despite the adverts! Connect thus:

Signal	TNC-220 J5	G3RUH MODEM J2
RXdata (in)	3*	17 Normal restore switch as per
RXdata (out)	4*	18 modem instruction sheets.
TXdata	19	19
Gnd	15	15
Txclock	see below	12

* Note, cut track between J5 pins 3 & 4

TXCLOCK: Obtain 19.2 kHz from the TNC's 74HC4020 divider chip pin 13, and connect to modem at J2-12, modem link LKC to "TNC-2".

Project OSCAR To Develop Ground Access System

Project OSCAR officials have reportedly authorized development of hardware and techniques for implementing a Community Access System (CAS) or Gateway for Phase 3C and Phase 4 satellites.

This development includes use of commercial modules where practical to minimize the test equipment and technical expertise needed by future CAS or Gateway developers, especially those located in rural communities or in other countries where building "from scratch" is difficult.

The system will feature:

Mode 1) Listen Only Mode

Mode 2) General Access Mode

Mode 3) Net, Bulletin, Teleconference Listen Only Mode

Mode 4) Net, Bulletin, Teleconference Interactive Mode

Mode 5) Repeater Link Party Line Mode

Mode 6) Repeater Link Gateway Assignment Mode

1) Listen Only Mode: Allows a repeater, remote base, or linear translator user to use touch-tone (TM) to tune around the OSCAR passband to determine activities there. This mode is an attractive "attention getter". It will be available to all participating repeater or LT groups.

2) General Access Mode: Similar to Mode 1 but allows uplink as well as downlink access to any part of the passband for systems and users having proper access codes (i.e., they have authorized access similar in concept to that required for autopatch, etc.). Compensation for Doppler shift, drift and other factors will be accomplished by the CAS.

3) Net, Bulletin, Teleconference Listen Only Mode: Similarly, all systems will have access to Net, Bulletin, and Teleconference activities but without two way access.

4) Net, Bulletin, Teleconference Interactive Mode: Same as Mode 3 but WITH two-way access.

5) Repeater Link Party Line Mode: For interlinking repeaters.

6) Repeater Link Gateway Assignment Mode: Authorized systems will also be able to use the RGAS or specific repeater-to-repeater "directed call" system.

John, (K2RDX), Ron (N2FIA), Ron (N6HBI), Paul (N6TX) and Jim (WB6JNN) are looking at various aspects of the RF, i-f, control, digital communications, and systems challenges involved.

Suggestions from interested parties are invited. Suitable topics for discussion might include: Protocols; possible related systems to be set up to use the remaining life of AO-10; how to prepare for Phase 3C; methods for further refining and modeling the system. Please contact:

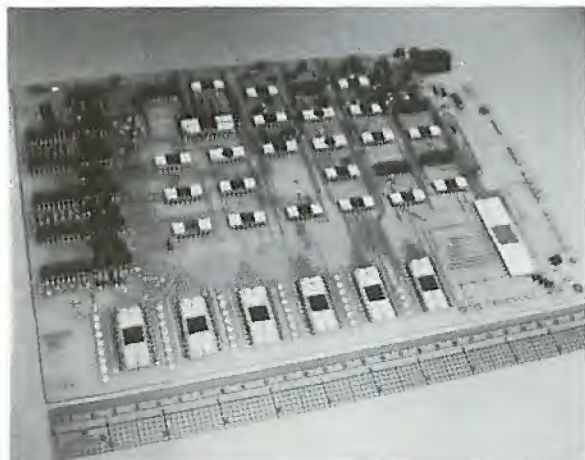
Jim Eagleson WB6JNN
President, Project OSCAR
15 Valdez Lane
Watsonville, CA 95076

Telephone (home) 408-724-2032; (office) 408-427-2248. More detailed information sheets are available for a large SASE with 2 units of postage affixed (\$0.39) please.

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